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ETHYL p-NITROPHENYL THIONOBENZENEPHOSPHONATE (EPN) CHEMICAL CHARACTERISTICS, BIOLOGICAL ACTIVITY, AND PESTICIDAL USE

By

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The last decade has been a notable period in the history of insecticides. The academic and industrial research catalyzed by the discovery of the insecticidal potency of DDT by Muller and his co-workers has produced several classes of highly effective synthetic organic chemicals which have in large measure replaced the pest control agents in common use ten years ago.

Some of the more useful of the newer insecticides are found among the organic compounds of phosphorus. The purpose of this paper is to summarize the chemical properties, biological activity, and pesticidal use of one of these compounds - ethyl p-nitrophenyl thionobenzenephosphonate (EPN).

EPN was first synthesized late in 1947. Laboratory and greenhouse testing in the winter of 1947-48 was followed by limited field evaluation in 1948 and extensive testing in 1949. Commercial use was achieved in 1950, concurrent with more tests on a wide variety of insect pests.

How EPN Is Prepared

EPN may be classed as a mixed alkyl aryl ester of thionobenzenephosphonic acid. The pure compound is a pale yellow, crystalline substance, m.p. 36°C. and refractive index $n_D^{80^\circ} = 1.5978$. The compound is soluble in most common organic

solvents, sparingly soluble in petroleum hydrocarbons, and very slightly soluble in water. Technical EPN is a dark amber liquid of moderate viscosity having a density of 1.27 at 25°C.

EPN is stable at ordinary temperatures in neutral, acidic, or even slightly alkaline solutions. Refluxing with strong alkali will hydrolize it quickly to ethanol, alkali p-nitrophenate, and alkali thionobenzenephosphonate.

As described by Jelinek (1950), EPN and related thionobenzenephosphonates may be prepared by a two-step process. In the case of EPN, for example, reaction of sodium ethylate with thionobenzenephosphonyl dichloride at room temperature in an inert solvent such as benzene or chlorobenzene yields ethyl thionobenzenephosphonyl monochloride. The latter can then be refluxed at 100-150°C. in an inert solvent with sodium p-nitro-phenate, and technical EPN isolated from the reaction mass by filtering from sodium chloride and removing the inert solvent by distillation. The technical EPN may be further purified by molecular distillation if desired.

Methods for Detection of EPN

Two analytical methods suitable for the detection of minute quantities of EPN are available. The Averell-Norris (1948) colorimetric technique is the preferred procedure. The principle employed is reduction of the nitro group to NH_2, followed by diazotization and coupling with N-(1-naphthyl) ethylene diamine to produce a blue color. This method is sensitive to ten micrograms with 95 percent recoveries of added EPN in known samples. An alternative analytical procedure is the total phosphorus method based on a modification of the molybdenum blue reaction (Holman 1943). The latter method is also sensitive to ten micrograms with recoveries of 95 percent.

In either method, the color intensity, measured with a photo-electric colorimeter, is compared with a calibration curve relating transmittancy and various concentrations of purified EPN carried through the procedure. Good checks between the two methods have been obtained.

In line with its relative stability, the biological efficiency of EPN is not impaired in combinations with most commonly used insecticides and fungicides except those forming highly alkaline solutions in water. Specifically, EPN is regarded as compatible with the compounds shown in Table 1. Experimental evidence indicates that the residual effectiveness of EPN may be lessened when used with Bordeaux mixture, and combinations with lime, lime-sulfur, and other strongly basic materials are not recommended.

Table 1. Pest control products compatible with EPN

"Aldrin"	"Methoxychlor" insecticide
BHC	Naphthalene acetic acid
"Chlordane"	Nicotine sulfate
"Cryolite"	"Parathion"
DDD	Phenyl mercury fungicides
DDT	Quinone fungicides
"Dieldrin"	Rotenone
Dithiocarbamates	SR-406 Fungicide
Dormant oils	Sulfur
Fixed copper fungicides	Summer oils
Glyoxalidine fungicides	TEPP
Lead arsenate	"Toxaphene"
Lindane	

Effect on Mammals

Several investigators have shown that EPN, in common with a number of other organic phosphorus compounds, is an anticholinesterase agent, and there is little doubt that its physiological effect is due in large measure to this property.

Considerable variation exists between different species of animals in susceptibility to EPN and in several species, notably rats, the females are more susceptible than the males. The wettable powder formulation of EPN is usually appreciably less toxic than the technical EPN on the basis of equivalent active ingredient.

In chronic oral toxicity studies with rats being carried out at the University of Rochester, the addition of up to 150 p.p.m. of EPN in the diet of male rats and up to 75 p.p.m. in the diet of female rats has resulted in no adverse growth effects by the end of 78 weeks.

Pesticidal Use

Dispersible powder, dust, and emulsifiable compositions of EPN have been used commercially and experimentally on a wide variety of crop and ornamental plants. No injury at effective dosages has been observed or reported except to apple varieties of the McIntosh group, and a single report on one variety of cucumbers. When used on McIntosh and related apple varieties (Cortland, Kendall, Macoun, Melba, etc.), particularly in early season sprays, EPN may cause injury characterized by distortion and sometimes burning of the younger leaves; more rarely, fruit injury consisting of dark spots may occur. The injury tends to be more severe when the EPN is applied in combination with spray oils or other oily liquids. Studies with various adsorbents and adjuvants as means of preventing this injury are in progress.

Most plants seem highly tolerant to EPN applications to the soil. In Delaware tests, corn, cotton, eggplant, lima beans, peanuts, potatoes, rye, squash, and tomatoes grew normally on soil treated with EPN 300 at the rate of 50 pounds per acre.

Greenhouse tests indicate that EPN is translocated in plants to a very slight extent, if at all. The 2-spotted mite developed normally on beans growing in soil containing 500 p.p.m. EPN.

Effect of EPN on Soil

Experimental evidence indicates that no soil poisoning problem is likely to arise from even heavy applications of EPN to field crops. Plots of soil of the Butlertown silt loam type near Newark, Delaware, were treated in November, 1950, with five, 20, and 50 pounds per acre of EPN 300. Samples of soil from the treated plots were taken in May, 1951, and analyzed for EPN content. The results, given in Table 2, indicate a fairly rapid disappearance from the soil. The addition of lime at the rate of 1000 pounds per acre had little effect on the rate of disappearance.

Table 2. Soil treatments with EPN 300

Rate of Application (November 1950)	p.p.m. EPN in soil (May, 1951) Replicate 1	Replicate 2
50	1.8	1.5
50 + 1000 lbs. lime	1.9	1.8
20	0.8	0.8
5	0.3	0.4

EPN was first developed as a mite control agent and has been used experimentally or commercially on most of the economically important phytophagous mites of the United States. It has given uniformly outstanding performance against the European red mite and good to excellent control of the Pacific, Schoene, Willamette, 2-spotted, citrus red, and several other mite species. The clover or brown mite (Bryobia pratensis) is not amenable to control by EPN.

Extensive tests over the past three years have demonstrated that EPN has a wide spectrum of insecticidal action. The material seems particularly useful on fruits, especially peaches, on which it effectively controls the plum curculio and Oriental fruit moth, as well as mites. Tests in the Midwest show EPN to be effective in European corn borer control and promising results have been obtained in the control of the cotton boll weevil and other cotton pests in preliminary tests. Many other insect enemies of fruits, field crops, and ornamentals have been successfully held in check with this product.

The persistence of toxic residues is a matter of concern with any chemical used for pest control on food plants. A considerable mass of analytical results of EPN residues on different crops is available. A study of these data shows that residues of EPN on plant surfaces are generally of a low order initially and are degraded at relatively rapid rates. Although dosage level and number of treatments influence the initial EPN residue, degradation of the residues on plant surfaces is sufficiently rapid that higher rates of application or more numerous treatments early in the season generally do not give proportionally greater residues at harvest.

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POLYTHENE SLEEVINGS USED FOR FUNGUS STUDIES IN GREENHOUSES

Use of polythene sleevings for greenhouse studies is reported in the May, 1951, issue of PHYTOPATHOLOGY, the official organ of The American Phytopathological Society.

At the John Innes Horticulture Institute at Bayfordbury, Hertford, England, it was desired to enclose separate shoots of trees in moist chambers to study the pear scab fungus. Since glass and plastic cylinders would be too heavy for this purpose, polythene was used. Originally sleeves 5 inches in diameter were made with strips of polythene sheeting 0.004 inch thick. The top and bottom were held in shape with aluminum wire, supported by a rod. A plug of cotton wool was placed around the branch at the bottom to permit gaseous exchange. A lighter sleeve was later developed, consisting of polythene of only 0.0015 inch thickness extruded in tube form. For small diameters, it was found that no internal aluminum spiral was necessary.

Since 1850 the American work force has increased six times, but the national income has increased 17 times. The reason is not more man effort. In 1850 the average workman worked 12 hours a day, six days a week and only 6 per cent of the work was done by machines. Since then we have increased our use of machines 250 times so that 90 per cent of the work of industry is now done by machines and the 40-hour work week is standard in America.

MODERN METHODS OF WEED CONTROL TOLD IN NEW BOOK

Up-to-date information on how to battle weeds is presented in a new book -- "Principles of Weed Control" -- written by a trio of scientists in this branch of agriculture.

Co-authors are Dr. Dale E. Wolf of Hockessin, Delaware, assistant manager of the Du Pont Company's Agricultural Biological Section; Prof. Gilbert H. Ahlgren, chairman of the department of farm crops, New Jersey Agricultural Experiment Station, Rutgers University; and Prof. Glenn C. Klingman, associate professor of agronomy at North Carolina State College.

"Principles of Weed Control" is a 368-page volume, containing 110 illustrations, published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York City. It traces the history of man's fight against weeds. Mechanical control measures, how and when cultivation practices may be employed, and the relatively new field of chemical spraying to eliminate weeds are discussed. Particular stress is placed on the many developments in weed control since the successful introduction of 2,4-D as a selective weed killer in 1944.

AMERICA BECAME GREAT BECAUSE IT GAVE SCOPE TO PERSONAL INCENTIVE

The widest scope for personal incentive is the fact of life that has made America great, Crawford H. Greenewalt, president of the Du Pont Company, said recently at Chicago. He spoke at the annual dinner of the Illinois Chamber of Commerce.

"I am convinced that those incentives are best which tend most strongly to advance the good of society as a whole," he said. "And nowhere have we a better demonstration of that thesis than in these United States."

The greatness of the United States is due simply to this fact: "Under our principle of individual liberty, human incentive has been given its widest possible scope," Mr. Greenewalt declared. He pointed out that all human accomplishments are important, but those of a limited few have been great; that all contribute to the common good but those at the top of their fields contribute more, since great individual success is never attained without bringing part of that success to others.

Chain Reaction of Accomplishments

He likened it to the neutrons in the atomic pile at the University of Chicago because "individual accomplishment marks the beginning of a chain reaction extending its influence far and wide."

Mr. Greenewalt noted that while Henry Ford acquired a great personal fortune, "it would be counted small when measured against the benefits his genius for mass production created -- in terms of employment, profit, and enjoyment for millions of people."

"The point is," he declared, "that rewards for individual achievement, no matter what form they take or what their amount, are at bargain-basement levels when measured against public benefits."

Incentives are simple and few in number: the inner satisfaction of doing our best; prestige; power and influence; but for most people the strongest incentive is financial gain because of what can be done with it, he said. Personal prestige is more likely to go with success in the sciences, universities, or professions, so business must balance this with financial reward if it will fill its ranks with able people, he continued.

Importance of Financial Incentives

"And so it is distressing to see financial incentives weakened by ever more steeply progressive personal income taxes," Mr. Greenewalt said. "If financial incentive is the strongest of the incentives we have to offer, it must of necessity follow that the nation's vigor will be weakened by its removal. And it is for the nation, not the individual, that we should be primarily concerned."

It is not a question of abandoning a large share of our present governmental activities because the revenue obtained at the cost of our incentive system is "pitifully small," he said. For 1948, the most recent year for which figures are available, all federal taxes collected on individual income above 25 per cent would run the government for less than a week at present proposed rate of spending.

If the financial incentive is absent or reduced too low, candidates for management positions will decrease, since many men will go into vocations where other rewards seem more desirable to them, he continued. The other motives that remain for industry are less desirable.

"Certainly the desire for power, or the desire for prestige, or admiration, are not characteristics that would be expected to lead to the kind of competence we need in business management," he said.

People Should Understand Tax System

"I think much could be gained if people knew the whole truth about our present tax system. When they do, they will realize that weakening of incentives hurts everyone, not just the more successful minority. And they will discover that the high cost of government is not being paid by the few but by the many -- that it is their pockets that are being tapped.

"I doubt that there is much to be gained by berating the administration or our representatives in Washington for Federal spending and governmental extravagance," Mr. Greenewalt said. "Those in public office after all reflect what they consider the wishes of their constituents to be. For that we cannot blame them.

"I do think, however, that we can fairly criticize government's unwillingness to tell the people the realities of the burdens they are asked to assume. It is as if they had no confidence in the native intelligence of the voting public; as if they adopted every means at their disposal to make them believe that government spending and the resultant high level of taxation were in some way removed from their own shoulders.

"I have the most complete faith in the wisdom and intelligence of an informed public. Our difficulties arise only when a few undertake to decide what is best for the great majority," he added.

Consumers Pay Corporate Taxes Eventually

Pointing to the corporate income tax, Mr. Greenewalt said he believed there was much misunderstanding as to who really pays it.

"It seems clear to me that corporation taxes in the long run are simply added to the cost of the goods and services the company has for sale. Just as prices must recognize an increase in labor and materials cost, just so must they take into account taxes levied by Government. For any business must earn a profit if it is to survive. That profit, furthermore, must be adequate to attract the capital necessary for growth and development. And so it is the customer at retail who must eventually pay the bill."

Mr. Greenewalt noted that, except in abnormal periods, industry's profit after taxes remains relatively constant, whatever the levy. He pointed out that in the mid-twenties the net profit after taxes for all United States corporations averaged 4.4 per cent with the federal corporation tax at about 13 per cent; in the three postwar years -- 1948,-49,-50 -- with taxes at 38 per cent, the net profit after taxes was 4.4 per cent.

Taxes Reduce Possible Price Decreases

Prices do not necessarily increase immediately every time taxes go up, Mr. Greenewalt said. For many products and many companies corporate income taxes have been offset by economies resulting from new technologies.

"Taxes in these cases have merely siphoned to Government cost reductions that would otherwise have reached the general public," he said.

"Taxation in sneakers is just as real and just as costly as taxation in hobnail boots," Mr. Greenewalt declared. The use of concealed taxes "is a sorry device to hide the fact that personal income taxes can no longer pay the bill," he asserted. "The rich, near-rich, and near-near-rich have by now been milked almost dry."

LARGE QUANTITIES IRON AND STEEL SALVAGED IN DU PONT SCRAP DRIVE

Enough iron and steel scrap to make the steel for 2,900 light tanks was shipped to the nation's steel mills by the Du Pont Company plants from May 1 through October, 1951. By means of a long-established salvage and reclamation program, Du Pont collected 70 million pounds of scrap iron and steel in response to the National Production Authority's plea for the scrap metal. Salvage of scrap is continuing through an intensive company-wide drive, just as it is on many farms throughout the country.

During the six-months period, the following amounts of critical non-ferrous metal scrap were salvaged: lead, 2,800,000 lbs.; copper, 1,180,000 lbs.; aluminum, 220,000 lbs.; nickel, 37,000 lbs.; zinc, 29,000 lbs. During the same period, thousands of usable pieces of equipment and machinery were delivered both to outside users and to Du Pont operations, making it unnecessary to order new equipment for those tasks.

Du Pont's salvage program began in 1907. The company, which has long recognized that good plant "housekeeping" goes hand in hand with good salvage operations, has also collected since the start of the stepped-up national campaign hundreds of tons of such materials as paper, chemicals, greases, solvents, containers, pipe, valves, electrical and mill supplies, and lumber. Also reclaimed are many small items such as workers' gloves and goggles and hand tools. This material is re-used on Du Pont plants and on defense projects outside the company. Salvage activities in Du Pont are coordinated by the salvage and reclamation organization of the Office Buildings Department.

(The following story originally appeared in the September 13, 1951 issue of THE OIL AND GAS JOURNAL, published at Tulsa, Oklahoma, and is reprinted here by courtesy of the editors).

B A T T L E A G A I N S T B R U S H

By Dr. A. E. Carlson
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On a 13-acre "laboratory" along a company canal, from the dehydration plant at De Large, La., to its junction with the Falgout Canal, United Gas Pipe Line Co. is solving a menace from brush and trees, threatening the company's vital communication system.

The company owns and operates 112 miles of telephone lines across marsh lands. This means 407 acres of right-of-way to be maintained along the line between plants and offices. About 22 miles of line parallels company canals, installed on spoil banks formed by mud dredged from the canal.

On these banks, vines, brush, and trees grow at an alarming rate, imperiling the line and weaving a thicket so dense a man must literally cut his way into it. If line trouble develops, it may require several days to reach the poles, to do a 30-minute repair job. A glance at the books also showed more than $100 an acre annually charged against brush control.

In the summer of 1949, Edward C. Greco, of United Gas Pipe Line Co.'s research department, set up a program to test chemical sprays along a 13-acre stretch of canal where growth was especially heavy. Wax myrtle, marsh elder, and willows were estimated to make up 95 per cent of the growth, combined with cypress, black willow, ash, elm, sweetbay, sugar maple, buttonbush, and a thick mat of blackberries.

A strip under the telephone lines was measured off 14,000 ft. long by 30 ft. wide. The chemical used was ammonium sulfamate, better known as "Ammate" weed killer, with a reputation for nonselectivity so far as species are concerned. Spraying was done from the deck of a canal boat equipped with tank and pump and moved along close up to the spoil bank.

Results that first season were disappointing, due to inadequate coverage. It was apparent that one hose, directed from boat-deck level, could not penetrate bankside brush sufficiently to wet growth under the lines. To remedy this, a diving-board-type platform was constructed, extending 5 ft. beyond the gunwale of the boat. This placed one spray-gun operator about 12 ft. above the spoil bank while another operator sprayed near-by growth from the top of the boat cabin.

In 1950 tests, the original plots were divided into subplots of an acre each, with 80-ft. untreated check plots between. In addition, three other plots of an acre each were staked out, in brush which had not been sprayed the year before. These were used to test high-gallonage applications——300 gal. of solution per acre as compared with 150 gal. on the other sections. The amount of chemical applied per acre was the same, however, the high-gallonage sprays merely carrying twice the amount of water.

Spray was applied late in April. Besides various concentrations of "Ammate," the hormone sprays, 2,4-D and 2,4,5-T were used in combination on some locations. General appearance of all sprayed areas a month later showed over-all coverage had been good and in early August a detailed evaluation of every plot was made.

In two of the subplots, one resprayed with "Ammate" at 1 lb. per 100 sq. ft., the other at 1/2 lb. per 100 sq. ft. plus a "spreader sticker" additive, the kill of all growth seemed so complete it was rated at more than 99 per cent.

The most startling evidence came from the three plots of virgin brush, sprayed for the first time in 1950. Here was proof that doubling the gallonage produced outstanding results.

On the acre sprayed with 6 lb. acid equivalent of 2,4-D and 2,4,5-T combination, an estimated 75 per cent top kill was found. Total kill was impossible to estimate until more time has elapsed.

Where "Ammate" was used at 1 lb. per 100 sq. ft., top kill was estimated at 95 per cent, and where only 1/2 lb. rate of the same chemical was applied, top kill was estimated at 92 per cent and a total kill including roots was estimated at 87 per cent——considered to be a remarkable performance from a single application.

On plots sprayed with the weed killer, root systems of 15 marsh elders were dug up and in every case showed an advanced stage of decay. In wax myrtles examined the same way, one out of seven showed a small amount of live, but sick-appearing, cambium near the junction of root and stem.

Cypress up to 8 ft. tall were dead in "Ammate" plots but not affected where the 2,4-D and 2,4,5-T was used. Willows were all dead and with decay well established in the roots. There was also much bark effect on both marsh elders and wax myrtles. Where the "Ammate" solution had hit the limb and run down a short distance, the cambium layer and bark was dark brown to black, with decay setting in.

Already, the switch from hand cutting to spraying is estimated to have effected a saving of 71 per cent in annual line-maintenance cost.

VARIETY OF LITTERS FOR BROILER PRODUCTION TESTED IN DELAWARE

Litters of organic materials such as peanut shells and ground corn cobs are better for broiler production than litters of inorganic origin, such as sand and mineral rock.

This is one of the conclusions reached in a six-year study conducted by the University of Delaware Agricultural Experiment Station at its substation in Georgetown, involving a total of 66,642 chicks. The substation is in the heart of Delaware's broiler area, where production of broilers jumped from 1,000 in 1924 to 73,000,000 in 1945, levelled off at about 60,000,000 per year, then rose to 71,881,000 in 1949 and 81,226,000 in 1950.

The tests were conducted by Karl C. Seeger, associate research professor, A. E. Tomhave, research professor, and W. C. Lucas, formerly research assistant, all of the Department of Animal and Poultry Industry of the University of Delaware. The work, carried out from 1942 to 1948, is described in technical bulletin No. 289 of the Agricultural Experiment Station, published at Newark, Delaware, in April, 1951. It is entitled: "A Comparison of Litters Used for Broiler Production."

Purpose of the extended study was to provide information for broiler producers regarding the desirability of one type of litter as compared with others, and the effect of litter type on the production performance of the chicks.

Twelve Different Litter Materials Studied

All the chicks used in the study were the progeny of a cross of Barred Rock males with New Hampshire hens. They were raised under conditions similar to those prevailing in the regular broiler farms, and marketed in the usual way. They were full fed on commercial broiler mash. Their pens were 30 feet long and 20 feet wide, and consisted of the original soil, slightly built up by an overlay of sand. Each pen was equipped with two coal burning brooder stoves and two automatic water fountains. Seventy-three pens, each with between 900 and 920 chicks were used, and the total involved amounted to 66,642 birds.

The 12 litter materials tested were sawdust, shavings, corn cobs, sand, sugar cane fiber, cotton seed hulls, peanut shells, corn stalks, peat moss, and three types of minerals. Fresh litter was placed in the pens for each new flock of birds.

The authors of the study stressed that suitability, availability, and cost of litter materials are always factors which must be taken into consideration by broiler producers.

Notes On Various Materials Used

The materials used by Messrs. Seeger, Tomhave, and Lucas in their study are fully described in their report. Here are some extracts from it:

Sawdust was the most readily available litter material in the vicinity of the Georgetown substation. Sawmills cutting loblolly pine produced sawdust of excellent texture, fine and uniform particle size, of agreeable odor and free from dust. Moisture content was around 35% when the sawdust came from the sawmill. Attempts to dry it on the floor by brooder stoves were not satisfactory. Air dried litters were found to contain 11 to 15% moisture.

Shavings from mills planing local rough cut lumber generally consisted of fairly heavy chips. Droppings remained on top, and caused rapid caking. Shavings from sash factories using kiln-dried soft pine were more satisfactory because they were fine and uniform.

Corn cobs were used in different ways. Delaware cobs were either broken or crushed in sticklike form, or ground, with particle size varying from three-fourths inch in diameter to a material as fine as corn meal. Since Delaware produces relatively little corn, cobs from Illinois were imported, with considerable addition in cost due to transportation charges. The Illinois cobs were kiln dried, steel cut, with particles uniformly of about one-half inch in diameter.

Sand of two types was used -- field and beach sand. The field sand, obtained on the farm, contained enough clay to create an extremely objectionable amount of dust. Beach sand was free of dust at the start, but "after a week of use an objectionable dust was created from dried droppings."

Sugar cane fiber, because of the length of the fibers, "tended to form a mat, especially after absorbing some moisture, so that the chicks were unable to stir it as well as the litters of fine texture."

Cottonseed hulls were rather expensive and tended to form in large balls on the toes of chicks. "Accumulation of litter on the soles of shoes was noted particularly." Objectionable dusts were created by chicks scratching in the dirt floor under the hulls.

Peanut shells were light and dry, of excellent texture. "There was a tendency for this litter to collect in the feed troughs, but this apparently did not interfere with feed consumption or growth. This was also true of the corn cob litter. The cost was about double that of sawdust."

Corn stalks were passed through a silage cutter and cut into lengths of about 1/4 of an inch, but the leaves went through and were blown into the pen in large strips. "These leaves accumulated on top of the litter. Moldiness was evident in underlying layers....but there was no evidence that the health of the birds was adversely affected."

Peat moss from Northern Maine and Canada was used, in lumps and in ground form. A two-inch layer was sufficient to prevent the chicks from scratching the underlying dirt. The lumps are useless unless broken down. The material is satisfactory, but transportation charges make it cost much more than sawdust.

Mineral rock litters of three types were used, two from Georgia and one from Nevada. They were absorbent and comparatively light in weight, and of different particle sizes.

A total of seven experiments were run. Two to five litters at a time were observed. In every experiment, sawdust was used as a standard for comparison. Careful records of the mortality losses from bronchitis and coccidiosis were kept, as well as computations of the average weight per bird, pounds of broiler sold per chick started, pounds of feed required per pound of broiler sold, litter cost in dollars per 1,000 chicks started, labor returns per 1,000 chicks started, and cost per pound of broiler sold.

Variation of Losses From Bronchitis and Coccidiosis

In the case of infectious bronchitis, the average losses were considerably greater in flocks raised on sand and mineral litters than on those raised on organic litters.

On the other hand, the "difference in mortality from caecal coccidiosis was less striking.... Variations..... were not consistent between litters in successive flocks, nor was there a correlation between observations and accumulated dampness or caking."

In one experiment, involving the use of sawdust, cottonseed hulls, and sugar cane fiber, there was an outbreak of caecal coccidiosis coinciding with intestinal coccidiosis, and a severe vitamin A deficiency, in the pen being raised on sawdust. The outbreak of the two types of coccidiosis did not coincide in the pens on cottonseed hulls and sugar cane fiber, and losses there were markedly less. In the other experiments, intestinal coccidiosis was of minor importance. Based on these facts the authors of the study came to this conclusion: "From the inconsistency of the losses from coccidiosis in all the experiments it appeared that the type of litter used had no influence on the severity of the disease."

Evaluation of Litters

The authors recognized that it was difficult to determine the materials in the order of their value as poultry litters, since all 12 were not compared with one another at the same time, under the same conditions. They made a relative evaluation of them, "based upon the production, results of mortality, average final weight, pounds of broiler production per chick started and pounds of feed required per pound of broiler produced," as well as on general observations of the broilers. It is as follows, in descending order of value:

1. Peanut shells. 2. Ground corn cobs. 3. Peat moss. 4. Sugar cane fiber. 5. Sawdust. 6. Shavings. 7. Cottonseed hulls. 8. Corn stalks. 9. Mineral rock.* 10. Sand. 11. and 12. - Mineral rock.*

* Three different brands of mineral rock were used.

INVENTION OF NEW MACHINES PLAYED VITAL ROLE IN AMERICAN AGRICULTURE

American science and production processes offer the hope of social gains far exceeding anything now known in any nation, Harold Brayman, Director of the Public Relations Department of the Du Pont Company, said recently. His talk, "Formula for Reform" was a feature of the annual meeting of the Paint and Varnish Production Clubs at Atlantic City, N. J.

Private business initiative, he said, has brought improvements in standards of living which centuries of reform agitation were unable to effect, and holds the brightest promise for further progress.

"None of our great social advances would have been possible at all if our dynamic economic development had not supplied the means," he said, noting that this applied to "every improvement contributing to our ease, comfort and convenience," and to all areas of human activity.

Discussing the farm question, Mr. Brayman said:

"This country has been hearing of agrarian reform since its earliest days. We have gone through many phases of it, from the first Homestead Acts to the Populist Revolt and on to the slaughter of the little pigs in the Thirties.

Agriculture Advanced Little Before 1800

"For thousands of years, farming was done chiefly by peasants, serfs and slaves, and their methods in 1800 A.D. had been substantially unchanged since the times of Nebuchadnezzar. When this country was founded it took nine people on the farm to feed themselves plus one city dweller. Today, in contrast, one man on a farm feeds himself, four city people and one person overseas.

"In the inventive environment of the early 1800's, change came to the farm in the shape of new tools. One was the iron and later the steel plow, which opened up whole new acreages formerly lying fallow. The reaper was invented in 1830, replacing the laborious practice of cutting grain with a scythe. In that year, the human labor factor required to produce one bushel of grain was three hours and thirty minutes. By 1896, this had fallen to 10 minutes, and we had not yet come to the next great phase of development.

"As we got into the gasoline age, the tractor became as important to the farm as the south meadow, and mechanization proceeded to every chore, from milking the cows to trimming the lawn. Today's farmer is indistinguishable from any other businessman, and bears no more resemblance to the cartoonists' picture of the hay-chewing rustic than does the businessman to The Daily Worker's drawings of him.

What Brought Advancement to Farm?

"We often hear that the farmers are the beneficiaries of an active lobby and that their favor is regarded lovingly by political candidates, and so it is. But I leave it to you as to whether the farmer's advancement has been due to laws,

legislation or bold speeches in Congress, or to the invention and development that today enable a single tractor to plow ten acres of land in a single day -- as much as an 18th Century settler could handle in months of hard, crushing toil.

"Or, as a sidelight on this field, one of the notable inventions giving rise to a social change was, of all things, barbed wire. All the title and claim laws defining property in the Western states had little validity to the farmer or rancher prior to 1875. There was no way to keep his cattle on his own land or the other fellow's off, for there were no fencing materials at hand. Cattle ranged far and wide, the round-up was expensive and the meat tough and stringy. Settlement of many areas was retarded. Not until Joseph Glidden fashioned the first barbed fence, taking his cue from a rosebush in his front yard, was it possible to develop the beef cattle business on a production basis. I hope whenever you eat a nice thick steak you will pay a silent tribute to the inventor who helped place it before you."

Invention and development, Mr. Brayman said, were responsible for the emancipation of women from "Eighteenth Century servitude" by freeing them from their most time-consuming and fatiguing efforts. "If it had not been for the invention of the cotton gin, the spinning jenny and other textile developments, women would have had little time or concern for equal rights," he said. "The real authors of emancipated womanhood were not Amelia Bloomer, Lucy Stone and Susan B. Anthony, but inventors like Eli Whitney, James Hargreaves and Richard Arkwright.

Leisure Results Largely from Machinery

"Modern machinery gave the American workman well-deserved leisure far more effectively than the cry for the 8-hour day, for without the means, the cry would have been empty and unheeded," said Mr. Brayman, who for many years was a Washington newspaper writer and political commentator.

Our standard of living, he pointed out, is after all no mysterious blessing from on high.

"If a family spends 300 hours of its income-producing time for a refrigerator that lasts six years, it has spent 50 hours a year to good advantage. But, if their next refrigerator costs 200 hours of labor and lasts ten years, then the six free years of operation contribute to funds for other purposes."

Still Areas Where Improvement Is Possible

Mr. Brayman said that he did not want to be misunderstood and that he conceded surely that all is not perfect under this system of ours. "Not all business is as fully aware of its responsibilities as we should hope," he said. "There are still, of course, injustices and frustrations that require attention. There are unquestionably areas of activity which need change and improvement, and there always will be.

"But let's be sure that we understand what is required for best results -- that we progress not through hazy and hasty expedients, but through the

application of our natural resourcefulness through bringing our technical capacities to more of our people, through lowering our costs and improving the performance of our industry.

"This is the true formula for reform. Let's make sure that we keep it firmly fixed in our minds. It is at once our record of the past and our best hope for the future."

LEGUME STAND INCREASE SHOWN AT NATIONAL PLOWING CONTEST

Thousands of persons who attended the 1951 national plowing matches at Bethany, Mo., last August, saw a newly-seeded pasture where an increased stand of plants had been achieved through the use of "Arasan" seed disinfectant.

On the farm of Glen Maize, where the plowing contest was held, a test planting was displayed involving this new use of "Arasan." As described in the Bethany REPUBLICAN-CLIPPER, Mr. Maize last April "seeded the pasture with a legume mixture, in cooperation with the soil conservation service. The seed supply was divided. Part of it was treated with Du Pont 'Arasan' and the remainder was untreated."

The seed was planted at the rate of 85 per square foot, said the REPUBLICAN-CLIPPER. On July 23, it added, John H. Gibson of the Bethany Soil Conservation Service office and Harold C. Olson of the Grasselli Chemicals Department of Du Pont at Omaha, Nebraska, inspected the pasture and made stand counts, with these results:

It was estimated that only 32% of the untreated seeds produced plants, while the treated seeds produced 62% -- almost double the stand. The paper added that "the plants from treated seed also were larger and more uniform. Other than having half the seed treated, the entire field was similarly handled." In describing how seed treatment is effective, the REPUBLICAN-CLIPPER said:

Causes of Big Difference in Yield Explained

"This difference is explained by the protection that the treated seed received. A seed is composed of a germ which is surrounded by the starchy part of the seed, and these two are enclosed by the seed coat. When the seed is placed in the soil, it is on its own. The germ sprouts and produces a seedling which must live entirely upon the starchy portion of the seed until it has emerged from the soil and developed leaves, stems and roots with which to produce its own food. It cannot borrow from its neighbor, as we humans sometimes do.

"All soils contain fungi and bacteria, many of which are harmful to seeds and plants. They cause seeds to decay, thereby robbing the small seedling of all or part of its food reserve. This results in the death of many seedlings, and leaves others stunted and weak. Poor growing weather for seeds is usually good growing weather for these parasites.

"A good seed protectant such as Du Pont 'Arasan' seed disinfectant is not harmful to seed or seedling, but is poisonous to the fungi that attack the seed. Thus a seed coated with this material will be protected from decay, and the seedling can be assured of a good supply of food. The result is usually more and healthier plants from the same amount of seed."

This was only one of 72 tests conducted by farmers in 19 states throughout the country during the past summer to prove the value of seed treatment in improved stands of grasses and legumes. They were described in the November-December 1951 issue of the Agricultural News Letter.

DU PONT BUYS PRODUCTS FROM THIRTY THOUSAND SUPPLIERS

A typical day's buying in the Du Pont Company involves 1,800 purchase orders and totals $2,500,000.

Salesmen call on the Purchasing Department, Wilmington, at the rate of one every 6½ minutes, adding up to nearly 19,000 visits a year.

About 30,000 suppliers sold the company $466,000,000 in goods and services in 1950. More than 3,000 separate items were supplied, ranging from hay and other farm products to locomotives.

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